COMPARISON OF SOME MEASUREMENT METHODS FOR PREDICTING
THE SITE SENSITIVITY (RUT FORMATION) IN THE PRACTICAL
HARVESTING OF WOOD

ABSTRACT

Three methods were compared in predicting the rut depth caused by a forwarder or harvester: 1) a method based on determining the E-modulus of the soil, 2) a WES-method based on the cone index (CI) indicating the penetration resistance of soil, and 3) a method based on determining the critical soil moisture. The E-modulus was measured by a deflectometer, the soil penetration resistance by a new penetrometer, and the soil moisture content by a time domain reflectometer (TDR). In addition, local environmental conditions, e.g. the soil types were recorded from each test area.

The problem to be studied was the following: Are the above-mentioned methods suitable for predicting the rut depth caused by a forwarder or a harvester in the practical harvesting of wood, and what kind of information do they produce for the decision-maker? The second problem was to find out, if there is a rough prediction method for estimating the rut depth, which can be used by the forest machine operators.

It so proved, that in Finnish soil conditions the WES-method is the best in predicting rut formation. However, there are some factors, which may be considered as weaknesses of the WES-method. The weight distribution of a forest machine may vary strongly in practical wood harvesting. The swinging and rocking of the vehicle, the slope and the load to be transported, may cause a lot of variation in the weight distribution. On the other hand the measuring of the dynamic weight distribution of the forest machine requires complicated calculations and tests, and is therefore very troublesome to use. Perhaps just these very facts mentioned above have affected the results gained in this study.
Although the water content of soil, especially the critical moisture, was not essential as an independent variable affecting the rut depth, it is known, that the soil water content has its meaning in developing a deep rut in practice. In future studies, one should focus efforts to determine, how do the different soil moistures affect the CI-values in case of different soil types.

Some examples on the best prediction models introduced in the study, were as follows:

\[ z_i = -0.185 + 0.024 \times N_{ci} - 0.037 \times M + \frac{5.249}{N_c} \]  (Model 13)

where

\[ Z_i = \text{rut depth, m (first pass)} \]
\[ M = \text{soil type} \]
\[ N_{ci}, N_c = N_{ci-}, N_{c-} \text{-value of the most significant soil layer} \]
\[ z_i = 0.050 + \frac{6.954}{N_c} - 0.030 \times M - \frac{1.276}{N_{ci}} + 0.003 \times D \]  

(Model 14)

where:

\[ D \]  

= Deflection value

Figure 1.2. Model 14

Report:
